U.S. Senate Committee on Appropriations

Subcommittee on Energy & Water Development

Hearing on Beneficial Reuse of Carbon Dioxide from Coal and Other Fossil Fuel Facilities

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Written Testimony

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Chairman Dorgan, Ranking Member Bennett and other members of the Subcommittee, it is a pleasure to speak to you today on the subject of beneficial reuse of carbon dioxide. I will be summarizing findings from a report Utah State University is jointly issuing with a number of other entities on opportunities, challenges, and research needs for algae biofuel production - emphasizing systems designed for carbon recycling from point-source CO_2 emitters.

America faces five interdependent challenges that threaten our prosperity and quality of life:

- energy price spikes,
- climate change,
- depletion of natural resources,
- high food prices, and
- an addiction to foreign oil

Although there is no single answer, algae energy systems represent a possible partial solution to all five challenges. Growing algae, the most productive of all photosynthetic life on earth, and converting it into fuels could help mitigate carbon emissions, reduce oil imports and price shocks, reclaim wastewater, and lower food prices.

Fundamentally, algae use solar energy and nutrients to transform CO_2 into organic material. Due to their simple biological structure, they capture carbon more rapidly than terrestrial plants and store it in a form that can be processed into fuels such as biodiesel. Some algal strains are capable of doubling their mass several times a day, and unlike terrestrial plants, algae can be cultivated on marginal or desert land using saltwater, brackish-, or wastewater. Since some species have a high affinity for CO_2, siting algae energy systems near point-source CO_2 emitters is an attractive option. Research has demonstrated that algal yields can be improved dramatically using enhanced concentrations of CO_2.

Because of its high lipid (or oil) content and growth rate, algae can produce 10 to 50 times more biodiesel per acre than, for example, soybeans. To compare the two feedstocks, if all the soybeans harvested in the U.S. were converted into biodiesel, the resultant fuel supply would accommodate less than 10% of our annual diesel fuel needs. Conversely, if an area roughly equating to 1/10th the area of either North Dakota or Utah were developed into algae energy systems, it would supply all of America's diesel fuel needs.

There is growing consensus that the fundamentals of algae energy systems are sound. As a recent article in National Geographic noted: *"there is no magic bullet fuel crop that can solve our energy woes without harming the environment, says virtually every scientist studying the issue. But most say that algae …comes closer than any other plant."*

But many challenges lie ahead and our analysis indicates that the overall lifecycle cost of algae energy systems must be reduced by at least a factor of two and probably more.

Unlike traditional crops, the technology needed to grow and harvest algae using industrial or agricultural processes is in its infancy. In the field of plant biotechnology, algae is one of the least explored areas. Recycling carbon is a new concept and there are challenges related to separating, compressing, and delivering CO_2 into algae cultivation systems.

To cultivate algae in open ponds, land and water (which must be replenished because of evaporative losses) are required. Energy is needed to keep algae cultures stable, healthy and growing. Invasive species, which can kill oil-rich algae, must be controlled. In enclosed growth systems, capital costs for equipment used to enclose, mix, and maintain cultures must fall. In both scenarios, surface shading limits the amount of sunlight that can be used constructively to produce biomass. After cultivation, algae must be dewatered and dried prior to oil extraction and fuel production. In each step along the way, energy and other resources are required.

But by harnessing the same biology, chemistry, and genetics that led to a doubling of yields in traditional crops, we should be able to do the same with algae. And advances in optics, mechanical engineering, and other disciplines are leading to scalable cultivation systems that better utilize sunlight and have the potential to reach cost targets.

Algae has the unique potential to produce renewable fuels and recycle carbon sustainably and *without* interfering with food supplies. To succeed, however, private and public cooperation is critical. Without it, the algae industry will struggle to reduce costs and integrate subsystems. Without regulations limiting carbon emissions, utilities, and in particular, small CO_2 emitters will have little motivation to explore reuse options.

Therefore, a robust and well-integrated RD&D program will only occur with government involvement both in sponsorship of R&D and enactment of policies in future energy and climate change legislation that accelerate commercial deployment.

We recommend that Congress authorize and appropriate funds for an algae-related RD&D program at the Department of Energy. It should include research on lifecycle analyses, leverage strengths of existing Department programs, and be coordinated from a Department-wide perspective. The program should take advantage of new program management tools and include a portfolio of activities ranging from foundational research to integrated demonstrations. Deployment projects should demonstrate the viability of technologies at a scale large enough to overcome infrastructure challenges and include regional partnerships similar to the Department's programs for geologic sequestration.

Thank you. I look forward to answering any questions.